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Facilities Condition Assessment and Capital Investment Model

Can You Accurately Report the Current Condition of Your Facilities

- Condition by:
  - Facility System
  - Individual Facility
  - Facility Classification or Type
  - Site
  - Agency

For Federal facilities, Federal Accounting Standards Advisory Board Standard #6 requires an annual facilities condition assessment

Do You Know?

- What condition your facilities should be to meet the mission, operations, safety, and habitability requirements of your agency
- The annual sustainment cost of your facilities
- The annual renewal or repair cost of your facilities
- The renewal/repair costs to increase the condition of your facilities to meet the mission, operations, safety, and habitability requirements of your agency

The Data Required to…

- Budget wisely
- Prioritize Renewal/ Repair $
- Justify your budget needs

What's Needed?

- Need method that:
  - Is low-cost
  - Can be updated annually
  - Is consistent and auditable
  - Flexible enough to provide useful information in a variety of ways; for systems, for facilities, for types of facilities for sites, and for entire organizations.

Low-cost, Consistent, Auditable

NASA Method
Acronyms

- **Current Replacement Value-** Cost and engineering estimate of materials, supplies, and labor required to replace a facility or item of equipment at its existing size and functional capability.
- **Deferred Maintenance -** Maintenance that was not performed when it should have been or was scheduled to be and which, therefore, is put off or delayed for a future period. (Federal Accounting Standards Advisory Board (FASAB), Statement of Recommended Accounting Standards Number 6, September 1995). Deferred maintenance DOES NOT include alterations and modifications, expansion in size or capability, work to address major technical or functional obsolescence, or other types of “new work.”

NASA Method
Acronyms

- **Maintenance –** The act of keeping fixed assets in acceptable condition.
- **Facility Condition Index-** Not the traditional definition which is DM / CRV. Based on system ratings, this is the weighted sum of condition ratings for all nine-facility systems. For each Center, the FCI is the weighted average of all nine systems for all Center facilities. For NASA it is the weighted average of all nine systems for all facilities.
- **System Condition Index -** This is the weighted sum of the systems similar to the FCI from the system level to the agency level

NASA Method
The Approach

- Utilizes Agency's Real Property Inventory (excludes land value) to create a database
- Use independent teams to complete the assessments
- Rapidly inspect systems (9) in each facility
- Rate condition of each system from 5 (Best) to 1 (Worst)
- Parametric models convert condition ratings to renewal/repair/capital investment cost estimate based on facility Current Replacement Value (CRV)
- Models account for different facility types (42)

Products: System Condition Index (SCI), Facility Condition Index (FCI), & DM Cost Estimate

NASA Method

Create the DM Database

Download the Agency's Real Property Inventory into the DM database

Facility types in the DM database:

- R&D and Test Buildings
- R&D Structures and Facilities
- Administrative Buildings
- Communications and Tracking Facilities
- Launch Pads
- Electrical Distribution
- Power Generation
- Substations
- HVAC Distribution
- HVAC Generation
- Potable Water Distribution
- PW Treatment Plants

42 DM Facility Categories are Based on NASA/DoD FACs & Designed to Account For As Much CRV as Possible

NASA Method
Assessment Methodology

- 2 person teams perform a rapid visual inspection of facilities
  - Use of Personal Digital Assistants (PDA) of all types
  - Key is the use of knowledgeable local escorts with each team
- Able to assess a few low-cost facilities without on-site visits
- Accounts for *all* facilities & considers age of systems

Cost < $.02 per square foot

NASA Method
Facility Systems

- **Structure** – foundations, slabs, floors, pavements
- **Roof** – roof, gutters, flashing
- **Exterior finishes** – walls, windows, doors
- **Interior finishes** – floors, walls, ceilings, doors, stairs
- **Electrical** – distribution, lighting, other wiring/controls
- **HVAC** – HVAC and other mechanical systems
- **Plumbing** – water, sewer, fire protection piping
- **Conveying** – cranes, elevators, hoisting equipment
- **Program Support Equipment** – test, research, program equipment

System Number and Types Can Vary From Agency to Agency

NASA Method
Condition Assessment Ratings

- 5 Condition Ratings
  - 5 (Excellent) – Only normal scheduled. maint. required
  - 4 (Good) – Some minor repairs needed; functions okay
  - 3 (Fair) – More minor repairs required; mostly functional
  - 2 (Poor) – Significant repairs required; system not fully functional for bldg use; does not meet all codes
  - 1 (Bad) – Major repair or replacement required to restore function; system unsafe
  - 0 (Absent) - A system that does not exist in a facility

NASA Method
Basis of the parametric model

- DODs *Parametric Cost Estimating System* (PACES); facilities construction data by facilities system
  - *PACES* is an integrated PC-based parametric budgeting and cost estimating system developed by Earth Tech that prepares parametric cost estimates for new facility construction and renovation. It is accepted estimating tool for federal construction projects that is based on an evaluation of more than $40 billion of federal facilities projects
- *RSMEANS* Construction/Repair data
  - is North America's leading supplier of construction cost information
- NASA Historical Repair/Renewal cost

Estimate Over a Large Number of Facilities

NASA Method
Functions within the database

- Managerial Tools
  - SCI, FCI, DM reports by Agency hierarchy, programs & facility categories
- Analyst Tools - Comparison between years
  - SCI, FCI, DM comparison from each assessment rating to the Agency including programs and facility categories
- DoD Facilities Sustainment Model (FSM)
- Facilities Managers' Interactive Facility Condition Goals Tool
- Facilities Incremental Condition Change Model (FICC)

NASA Method

Facilities Incremental Condition Change Model (FICC)

- Determines the *required condition* of facilities to meet mission, operations, safety & human health/comfort issues based on *facility condition goals* and lowest acceptable condition.
- Determines the amount of renewal/repair/ capital investment cost per 1/10 incremental increase (or decrease) in a site's facilities condition.
- Gives a manager the amount of renewal/repair/capital investment cost to increase the condition of a site's facilities by any increment up to a "5" including the target rating.
  - Also, prioritizes work effort, to get the greatest condition increase with the least amount of expenditure

NASA Method
Results Table

Facility Description	CRV($M) Total	Current FCI	Recommended FCI Goal	Total Renewal/ repair required ($M)	$ (M) required to meet Recommended FCI Goals (All Facilities)	$(M) required to meet Recommended FCI Goals (Active Facilities)	% CRV DM Goal per Category
Site 1	$6,123	3.8	4.4	$481	$422	$340	8%
Site 2	$2,813	3.8	4.6	$197	$184	$73	7%
Site 3	$1,520	3.0	4.0	$474	$439	$428	31%
Facility Type 1	$1,456	3.5	4.0	$107	$92	$69	7%
Facility Type 2	$1,446	3.8	4.4	$132	$115	$82	9%
Agency Total	$22,762	3.6	4.3	$2,269	$2,007	$1,597.2	10.0%

NASA DM Parametric Estimating Method

- ✓ Achieves at a reasonable, auditable result that meets established accounting standards
- ✓ Meets FASAB #6 requirements as an annual facilities condition assessment
- ✓ Produces both a system condition index & a facility condition index based upon rapid visual inspections all facilities
- ✓ Produces a credible estimate of deferred renewal/repair/capital investment cost as a direct result of a very low cost facility condition assessment using parametric modeling based on historic data
- ✓ Estimate the amount of capital investment to incrementally increase (or decrease) a site's facilities condition.

A Strategic Tool That Aids Facilities Managers in Planning and Budgeting

Plexus Scientific is Easy to Work With

- Existing Contract Vehicles
  - MOBIS # GS-10F-0035K

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Back up Slides

Conclusion

- Using the NASA method of assessment and DM/renewal estimating method the facility manager now has a tool that can;
  - Budget wisely
  - Prioritize Renewal/ Maintenance $
  - Justify your budget needs
  - And,

Conclusion

- This process answers questions, such as:
  - What is the current condition of our facilities?
  - What condition do they need to be in to continue to operate successfully and safely?
  - How much will it cost to raise the condition to operate successfully and safely?
  - Over time are my facilities improving in condition or at least remaining in the same?

Results

- Low-cost, flexible facilities assessment that meets FASAB #6 requirements
- Can be compared and trended annually from the system level to the Agency level and by facility class/category to determine if your program is successful
- An auditable, consistent method to determine DM/renewal cost as a *direct result of the condition* of your facilities

Results

- A method to determine the *required condition* of your facilities to meet mission, operations, safety & human health/comfort issues.
- The capital investment costs to *incrementally increase the condition* of your facilities to meet the mission, operations, safety, and habitability requirements of your agency.
- All this in a single database that also uses the DOD FSM to determine annual sustainment cost

History of FICC Model

- BMAR Limits Task
  - To establish limits (BMAR as % of CRV) for the Agency and by discrete facility type.
- First FICC Task
  - How much does it cost to increase the condition of our facilities?
  - Curve fitting
- DM Limits II Task
  - DM Limits
  - Rules model for cost to incrementally increase facilities condition.

BMAR Limits Task 1

- Determine established industry standards
- Determine if other are other organizations with such a standard.
- Conclusions
  - Organizations have different definitions and metrics for BMAR
  - None have established firm BMAR limits
  - Definitions for what is included in BMAR and BMAR levels in other federal and public agencies fluctuate significantly
  - Comparisons of facilities performance among agencies are impossible due to variations in BMAR definitions, facility ages, and other factors
- Use available data to do the same thing- DM

BMAR Limits Task 1

- Purpose: To establish limits (BMAR as % of CRV) for the Agency and by discrete facility type.
- Use as a performance metric and budgetary tool.
- Determine impact of Agency backlog of maintenance and repair (BMAR) levels on facility degradation, mission support and safety.

Incremental Condition Increase Task

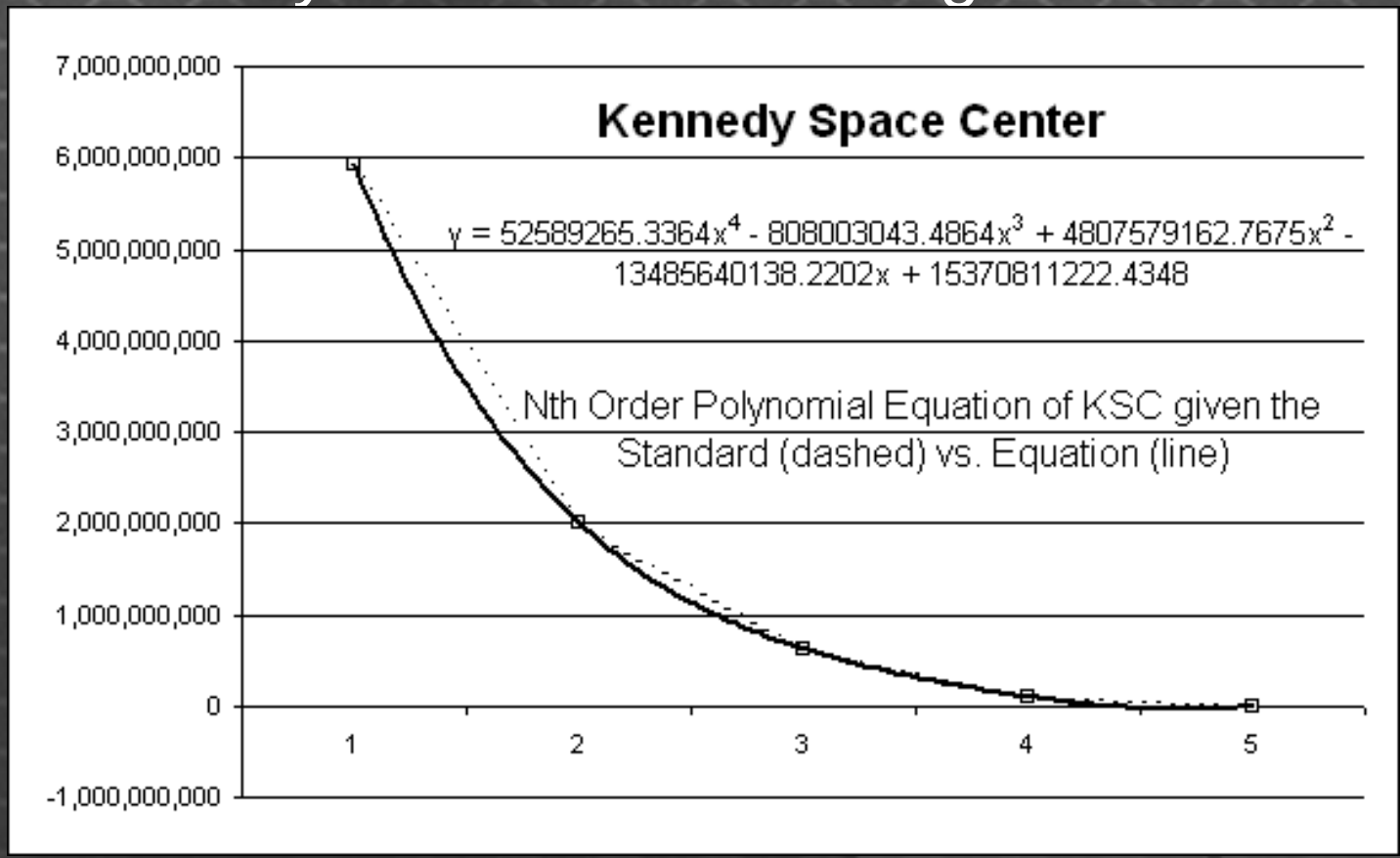
- Purpose: To develop a method that calculates an incremental increase in deferred maintenance cost based on an incremental increase in a facilities condition for use during the planning, programming and budgeting cycle to estimate the maintenance cost required to increase a group of facilities' condition to a more acceptable condition.

Incremental Task

- Two options
  - Used defined heuristic rules to change the assessed ratings of the individual buildings systems
  - Involved estimating discrete interval changes based on standard values for all systems in the subset – "Curve fitting." The basis of the DM System Condition Percentages
- Option 1 although preferable, too hard within the time restrictions

Incremental Task
Option 2 A– "Curve Fitting"

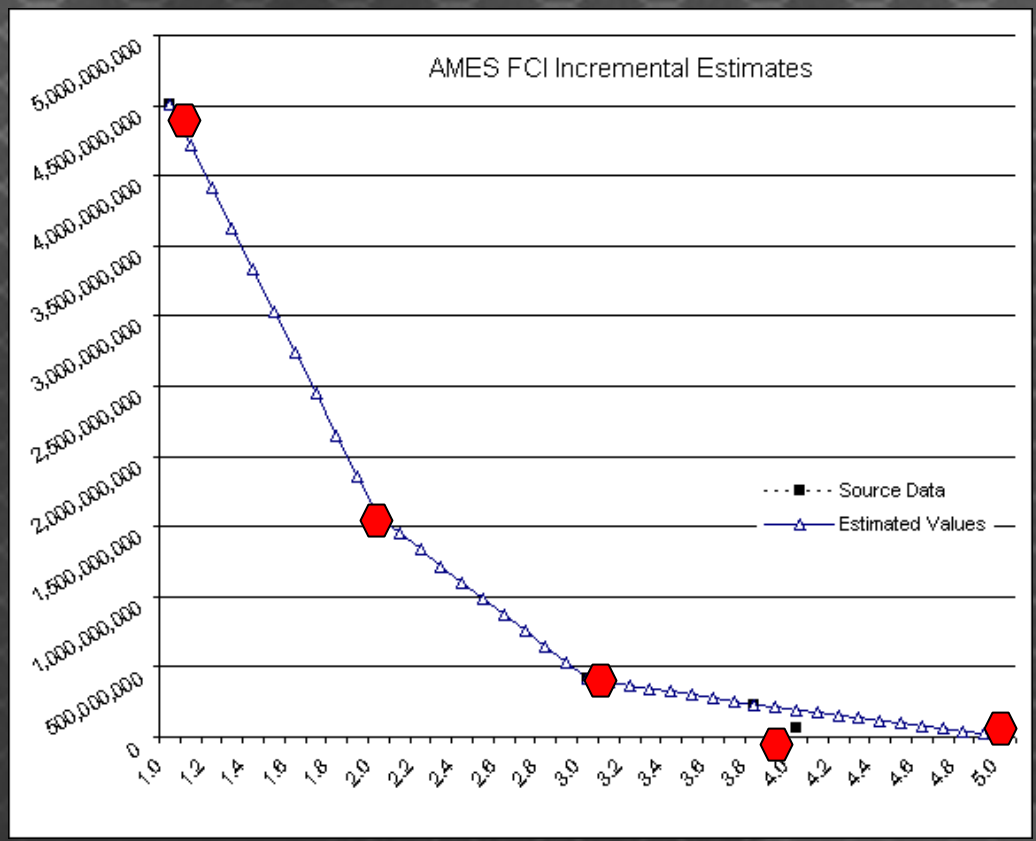
- 4th Order Polynomial Curve Fitting



The 4th order polynomial poorly represented the data in the interval of NASA's greatest interest, the interval of 3.5 to 4.5.

1st FICC
"Curve Fitting"

- 1st Order Polynomial Curve Fitting



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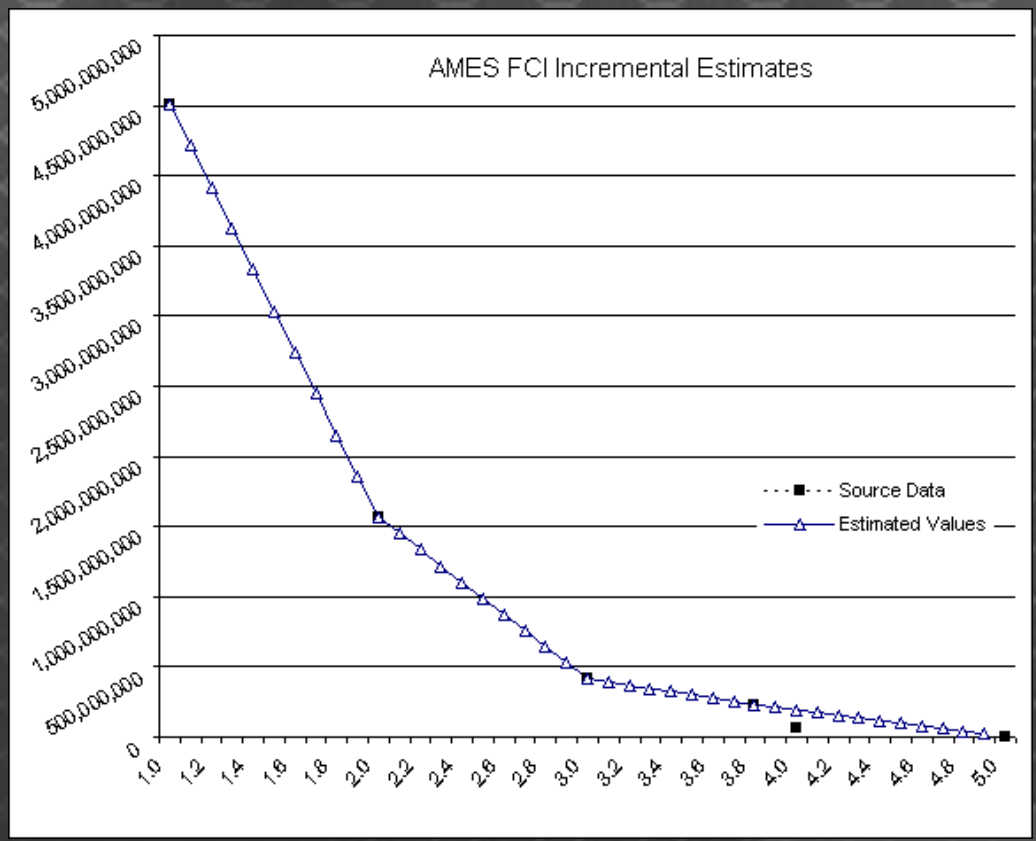
1st FICC
"Curve Fitting"

NAME	2002 CRV	Rptd FCI	3.4	3.5	3.6	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0
Ames Research Center	$2,373	4.1								$0	$12	$24	$36	$48	$60	$72	$84	$97	$109
Crows Landing	$88	2.9	$6	$7	$7	$8	$9	$10	$11	$11	$11	$12	$12	$12	$12	$12	$12	$12	$12
Camp Parks	$5	3.5		$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1	$1	$1	$1
Moffet Federal Airfield	$1,152	3.3	$13	$25	$38	$51	$64	$76	$89	$91	$93	$95	$97	$99	$101	$103	$105	$107	$109
Ames Research Center Total	**$3,619**	**3.8**					**$0**	**$64**	**$128**	**$138**	**$148**	**$158**	**$169**	**$179**	**$189**	**$199**	**$210**	**$220**	**$230**
Code R (Aerospace Technology) Total	**$8,911**	**3.7**				**$0**	**$173**	**$345**	**$518**	**$546**	**$574**	**$602**	**$630**	**$658**	**$686**	**$714**	**$742**	**$770**	**$798**
Nasa Total ($M)	**$22,165**	**3.6**			**$0**	**$360**	**$720**	**$1,080**	**$1,440**	**$1,499**	**$1,558**	**$1,617**	**$1,676**	**$1,734**	**$1,793**	**$1,852**	**$1,911**	**$1,970**	**$2,028**
Shuttle Pgm ($M)	**$6,132**	**3.4**	**$0**	**$89**	**$179**	**$268**	**$358**	**$447**	**$537**	**$552**	**$567**	**$582**	**$597**	**$612**	**$627**	**$642**	**$657**	**$672**	**$688**

Incremental Task
Option 2 B– "Curve Fitting"

- 1st Order Polynomial Curve Fitting



Incremental Task
Conclusion

- Change in cost is accurate within the precision of the DM parametric cost estimate method
- Facilities management tool will be useful in helping NASA management during the planning, programming and budgeting cycle
- Aid in the prioritization of maintenance spending between Enterprises, Centers, sites, types of facilities and even facilities systems

DM Limits II

- Purpose: To establish limits (DM as % of CRV) for the Agency and by discrete facility type.
- Use as a performance metric and budgetary tool.
- Determine impact of Agency DM levels on facility degradation, mission support and safety.

DM Limits II
Procedures

- Further define ratings
- Establish limit and target condition rating per system
- Determine limit and target FCI per facilities class
- Determine limit and target DM per facilities class
- Apply to all DM facility categories
- Determine % CRV that DM lower limit and target equate to.

Rules-Based Model for FICC

- Curve-fitting was a logical process for an estimate, but was not optimal.
- Rules-based model
  - Increased fidelity of estimate because it is based on assessment ratings, DM limits, CRVs impact, facility categories, and a managerial decision making process
- Added and deleted rules
  - Cause and effect
- Analyze results

Rules-Based Model for FICC

Name	3.4	3.5	3.6	3.7	3.8	3.9	4	4.1	4.2	4.3	4.4	4.5	5
Ames Research Center				303,036,270	281,606,384	220,439,265	209,461,488	199,966,951	160,314,081	78,518,730			
Dryden Flight Research Center										7,441,237	4,804,259		
Glenn Research Center			292,036,889	257,438,810	245,279,871	239,261,749	222,221,572	188,888,518	164,674,483				
Langley Research Center				153,134,567	126,478,860	111,504,814	95,990,303	85,128,623	80,625,944	68,768,551	43,295,969		
Code R (Aerospace Technology)				755,648,963	676,838,895	621,576,125	545,044,544	506,644,068	432,162,999	317,722,627			
Goddard Space Flight Center								91,288,781	75,349,919	53,125,709			
Code Y (Earth Science)								91,288,781	75,349,919	53,125,709			
Jet Propulsion Laboratory							85,770,278	78,229,029	74,130,299	64,955,159	51,137,973		
Johnson Space Center			135,887,306	125,141,930	112,723,434	86,643,295	79,977,497	58,510,571	37,649,902				
Kennedy Space Center	831,140,361	726,258,731	719,531,148	674,332,815	632,222,068	567,943,205	463,850,002						
Marshall Space Flight Center					124,938,231	89,238,544	80,654,116	73,809,269	65,557,447	50,220,619	33,471,409		
Marshall Space Flight Center			233,493,624	189,316,693	177,265,600	148,754,672	122,555,374	94,565,032	65,888,609				
Stennis Space Center		115,077,002		90,074,432	87,596,682	78,412,413	72,973,961		41,610,343				
Code M (Human Exploration and Development of Space)		1,315,598,294	1,149,520,787	1,102,096,786	1,020,423,759	898,560,605	804,474,509	632,264,449					

FICC Steps

Example
(89 total steps)

Step	Group	System	Criteria	Update
1	Electric	Electric	2	5
2	Electric	Electric	3	5
3	Electric	Structure	2	5
4	Electric	Structure	3	4
5	Electric	HVAC	2	5
6	Electric	HVAC	3	5
7	Electric	Exterior	2	4
8	Electric	Exterior	3	4
9	R&D	Electric	2	5
10	R&D	Electric	3	5
11	R&D	Electric	4	5
12	R&D	Equipment	2	5
13	R&D	Equipment	3	5
14	R&D	Equipment	4	5
15	R&D	HVAC	2	5

DM Parametric Method
System CRV Percentages

DM Codes	NASA Building	Structure	Roof`	Ext	Interior Finishes	Electric	HVAC	Plumb	Conv	Equip
1	R& D and Test Buildings	.18	.04	.19	.15	.20	.15	.04	.01	.04
2	R&D Structures And Facilities	.40	.01	.17	.03	.25	.06	.02	.02	.04
3	Wind Tunnels	.30	.01	.05	.01	.15	.01	.01	.01	.45
29	Berthing And Housing	.15	.09	.17	.16	.18	.16	.07	.02	0

Based on DoDs *PACES* model

DM Parametric Method

System Condition CRV Percentages

SYSTEM	5	4	3	2	1
STRUC	0	1	10	25	150
ROOF	0	9	38	75	150
EXT	0	1	10	50	101
INTF	0	1	10	50	101
ELEC	0	2	13	63	133
HVAC	0	2	13	63	133
PLUMB	0	2	10	57	121
CONV	0	2	13	50	100
PSE	0	2	13	50	100

% over 100 account for demolition and disposal costs

Based on *RS Means* Estimating Tools and Survey of Actual Maintenance and Repair Cost

DM Parametric Method
FCI Calculations

- FCI calculations
  - Individual Systems
  - Individual Facility
  - Installation

System Condition Index

			STRUC				
Facility Description	PRV ($M)	DM Cat.	Insp Rate	% Sys CRV	Value of System	Normalization to value of systems	SCI
MATERIAL/EQUIPMENT STORAGE	$52,593	28	2	0.63	$33,133.59	0.000528284	0.001056568
WAREHOUSE	$1,172,019	7	4	0.4	$468,807.60	0.007474695	0.02989878
COVERED STORAGE	$102,267	9	5	0.63	$64,428.21	0.001027247	0.005136235
MAINTENANCE EQUIPMENT STORAGE SHED	$93,401	28	5	0.63	$58,842.63	0.00093819	0.004690951
FEMA EQUIPMENT STORAGE SHED	$92,789	28	5	0.48	$44,538.72	0.000710128	0.003550639
GENERAL WAREHOUSE	$7,781,631	8	4	0.6	$4,668,978.60	0.074442461	0.297769842
ADMINISTRATION BUILDING	$12,166,903	5	5	0.19	$2,311,711.57	0.036858061	0.184290304
AUDITORIUM	$6,306,944	5	3	0.22	$1,387,527.68	0.02212282	0.066368461
MAIN LIBRARY	$5,716,090	5	5	0.19	$1,086,057.10	0.017316156	0.086580781
COMPUTATIONAL FLUID DYNAMICS BUILDING	$1,450,139	1	4	0.18	$261,025.02	0.004161798	0.016647191
PHOTOTECHNOLOGY LAB.	$10,960,633	1	4	0.18	$1,972,913.94	0.031456252	0.125825009
NACA MONUMENT & TIME CAPSULE	$13,923	25	5	0.9	$12,530.70	0.00019979	0.000998951
ADMINISTRATIVE SUPP.BLDG.	$17,241,384	5	4	0.19	$3,275,862.96	0.052230545	0.208922182
SPACE TECHNOLOGY BUILDING	$775,998	1	4	0.19	$147,439.62	0.002350786	0.009403143
PILOT MODEL OF 3.5 FT HWT	$322,353	3	5	0.76	$244,988.28	0.003906107	0.019530535
12 FT PRESSURE WIND TUN.	$155,601,694	3	5	0.3	$46,680,508.20	0.74427668	3.721383398
	$219,850,761				$62,719,294.42		4.8

A System Condition Index is calculated by first determining the CRV of the system in question by multiplying the % system CRV by the facility CRV. These system CRVs are then totaled. Next, the system CRV for each facility is normalized or weighted by dividing the system CRV by the sum of all the system CRVs. This quotient is then multiplied by its respective assessment rating. These "weighted" SCI are then added together to determine the facilities SCI

FCI Calculation
Individual Facility

			STRUC		ROOF		EXT		INTF		ELEC		HVAC		PLUMB		CONV		EQUIP		FCI
Facility Description	PRV ($M)	DM Cat.	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	Insp Rate	% Sys CRV	FCI
ADMINISTRATION BUILDING	$12,166,903	5	5	0.19	3	0.06	5	0.17	5	0.16	4	0.18	4	0.16	4	0.05	5	0.03	0	0	4.5

The FCI is CRV normalized sum of the condition ratings for each system within each facility. In other words, facilities or systems with a higher CRV contribute more to the overall FCI. The building FCI is a simple calculation that weights each of the nine system condition ratings by its associated system CRV percentage per DM category. In each system, the rating is multiplied by its system CRV percentage to get a weighted SCI. The sum of the nine weighted SCIs equals the facility's FCI.

FCI Calculation
Installation

Facility Description	PRV ($M)	DM Cat.	FCI	% PRV	Norm FCI
	$21.39				
LAND	$0	26	0.0		
MATERIAL/EQUIPMENT STORAGE	$52,593	28	2.0	0.0002	0.0005
WAREHOUSE	$1,172,019	7	3.3	0.0053	0.0178
COVERED STORAGE	$102,267	9	5.0	0.0005	0.0023
MAINTENANCE EQUIPMENT STORAGE SHED	$93,401	28	5.0	0.0004	0.0021
FEMA EQUIPMENT STORAGE SHED	$92,789	28	5.0	0.0004	0.0021
GENERAL WAREHOUSE	$7,781,631	8	3.9	0.0354	0.1380
ADMINISTRATION BUILDING	$12,166,903	5	4.5	0.0553	0.2485
AUDITORIUM	$6,306,944	5	3.1	0.0287	0.0889
MAIN LIBRARY	$5,716,090	5	4.2	0.0260	0.1089
COMPUTATIONAL FLUID DYNAMICS BUILDING	$1,450,139	1	4.2	0.0066	0.0274
PHOTOTECHNOLOGY LAB.	$10,960,633	1	3.9	0.0499	0.1924
NACA MONUMENT & TIME CAPSULE	$13,923	25	5.0	0.0001	0.0003
ADMINISTRATIVE SUPP.BLDG.	$17,241,384	5	3.6	0.0784	0.2839
SPACE TECHNOLOGY BUILDING	$775,998	1	4.0	0.0035	0.0141
PILOT MODEL OF 3.5 FT HWT	$322,353	3	4.7	0.0015	0.0068
12 FT PRESSURE WIND TUN.	$155,601,694	3	5.0	0.7078	3.5388
	$219,850,761			1	4.7

The Center FCI value is a sum of each facility's CRV normalized FCI. Each facility CRV is divided by the total Center CRV. That quotient is then multiplied by each facility's FCI producing a CRV normalized FCI. (Weighted FCI = (Facility CRV÷ Center CRV) × Facility FCI). The sum of these weighted facility FCIs provides a total Center FCI.

DM Parametric Method

DM Calculations for a Facility

Systems	System %	System % PRV	System Rating	System Conditon PRV %	Deferred Maintenance ($T)
Stucture	0.19	2,311,712	5	0	$0.00
Roof	0.06	730,014	3	38	$277,405.39
Exterior	0.17	2,068,374	5	0	$0.00
Interior	0.16	1,946,704	5	0	$0.00
Electrical	0.18	2,190,043	4	2	$43,800.85
HVAC	0.16	1,946,704	4	2	$38,934.09
Plumbing	0.05	608,345	4	2	$12,166.90
Conveyance	0.03	365,007	5	0	$0.00
Program Support Equipment	0	0	0	0	$0.00
	1	12,166,903			$372,307.23

The facility DM estimate is determined by adding the deferred maintenance estimates of the nine facility systems. All the facilities in each installation are added together to get an installation cost estimate